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Applicant	:	Jacques SCHMITT
Serial No.	:	N/A
Filing Date	:	Concurrently Herewith
Examiner	:	N/A
GAU	:	N/A
For	:	PLASMA REACTOR FOR THE TREATMENT OF LARGE SUBSTRATES

Commissioner for Patents
Washington, D.C. 20231

Attention: Box Patent Applications

PRELIMINARY AMENDMENT

Sir:

Prior to examination, please amend the above-identified application, as follows:

IN THE SPECIFICATION:

Page 1, line 1: (after the Title) Please add the following paragraph identified as "Insert A" on the enclosed page:

--**Cross-Reference to Related Applications**

This application is a divisional application of U.S. Application Serial No. 09/401,158, filed September 22, 1999, now U.S. Patent No.--.

IN THE CLAIMS:

Please cancel Claims 13-15.

Please amend Claims 3 and 5-11, as follows:

3. (Amended) The reactor of claim 1, characterized in that said dielectric layer has a thickness (e_1) along a direction perpendicular to the general surface of the substrate, said thickness being non uniform along said dielectric layer, so that the reactor has said location dependent capacitance per unit surface values.

5. (Amended) The reactor according to claim 1, characterized in that said dielectric layer (15) has at least one non planar-shaped external surface.

6. (Amended) The reactor according to claim 1, characterized in that at least one of said electrodes has a non planar-shaped surface facing the substrate.

7. (Amended) The reactor according to claim 1, characterized in that:

said one dielectric layer is locally delimited by a surface of one of said electrodes (5a, 41b, 51b), and

said delimitation surface of said one electrode is curved.

8. (Amended) The reactor according to claim 1, characterized in that said dielectric layer comprises at least one of a solid dielectric layer and a gaseous dielectric layer, or a combination of the both mentioned.

9. (Amended) The reactor according to claim 1, characterized in that the at least one substrate comprises a plate having a non planar-shaped external surface.

10. (Amended) The reactor according to claim 1, characterized in that the at least one substrate (65) has a curved shape.

11. (Amended) The reactor according to claim 1, characterized in that spacing members are arranged between said substrate (35', 65) and one of the electrodes (25, 45), said spacing members having elongations being non uniform.

REMARKS

Claims 1-12 are in this application, and presented for the Examiner's consideration.

By this amendment, applicants have corrected reference to improper multiple dependent claims, and have also indicated that this application is a divisional application of U.S. Serial No. 09/401,158.

Applicants enclose a copy of the marked up sheets indicating the changes made to the specification and claims.

No new matter has been added to this application.

It is, therefore, respectfully requested that this Amendment be entered into the file of this application.

Respectfully submitted,

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Plasma reactor for the treatment of large size substrates

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The invention relates to a capacitively coupled radiofrequency (RF) plasma reactor and to a process for treating at least one substrate in such a reactor. Especially, the present invention applies to a large size capacitive capacitively coupled (RF) plasma reactor.

Often, such a reactor is known as a "capacitive" RF glow discharge reactor, or planar plasma capacitor or parallel plate RF plasma reactor, or as a combination of the above named.

Capacitive RF plasma reactors are typically used for exposing a substrate to the processing action of a glow discharge. Various processes are used to modify the nature of the substrate surface. Depending on the process and in particular the nature of the gas injected in the glow discharge, the substrate properties can be modified (adhesion, wetting), a thin film added (chemical vapour deposition CVD, diode sputtering) or another thin film selectively removed (dry etching).

The table shown below gives a simplified summary of the various processes possibly performed in a low pressure capacitive discharge.

Industry	*Substrate type*	*Process*	*Inlet gas nature*
Semiconductor	wafer up to 30 cm diameter	- Surface Cleaning - PECVD - Dry Etching - Ashing	- Ar - SiH_4, ... - CF_4 , SF_6 , Cl_2 ,... - O_2,
Disks for memory	Polymeror glass up to 30 cm diameter	- Diode sputtering - PECVD - Surface activation	- Ar + others - Organometallics - O_2 , etc...
Flat display	Glass up to 1.4 m diagonal	Same as for semiconductors	Same as for semiconductors
Window pane Web coaters	Glass up to 3 m width, foil, plastic or metal	-Cleaning/ activation, Nitriding, polymer PECVD	- Air, Argon – Monomer, Nitrogen, ...

- an additional radiofrequency generator (93) connected to at least one of the electrodes (3, 45), for increasing the ion bombardment on said substrate,
- means (8) to evacuate the reactive gas from the reactor,
- the at least one substrate (35) defining one limit of the internal process space to be exposed to the processing action of the plasma discharge, said at least one substrate extending along a general surface and being arranged between the electrodes,

characterized in that said plasma reactor (1, 20) further comprises at least one dielectric layer (95) extending outside the internal process space, as a capacitor electrically in series with said substrate (35) and the plasma, said dielectric layer (11) having capacitance per unit surface values which are not uniform along at least one direction of said general surface (15a), for generating a given distribution profile, especially for compensating a process non uniformity in the reactor.

3. The reactor of claim 1 ~~or claim 2,~~ **characterized in that** said dielectric layer has a thickness (e_1) along a direction perpendicular to the general surface of the substrate, said thickness being non uniform along said dielectric layer, so that the reactor has said location dependent capacitance per unit surface values.

4. The reactor according to claim 3, characterized in that :
- the said dielectric layer (15) is the thickest in front of the location in the process space (13) which is the farest away from said connection location (9a) where the radiofrequency generator is connected to said at least one electrode,
- and said thickness decreases from said process space location as the distance between the process space location and the connection location on the corresponding electrode decreases.

5. The reactor according to claim 1, ~~anyone of claims 1 to 4,~~ **characterized in that** said dielectric layer (15) has at least one non planar-shaped external surface.

6. The reactor according to ~~anyone of claims 1 to 5,~~ claim 1, **characterized in that** at least one of said electrodes has a non planar-shaped surface facing the substrate.

7. The reactor ~~of anyone of claims 1 to 6,~~ according to claim 1, **characterized in that**:
- said one dielectric layer is locally delimited by a surface of one of said electrodes (5a, 41b,51b), and
- said delimitation surface of said one electrode is curved.

8. The reactor according to ~~anyone of claims 1 to 7,~~ claim 1, **characterized in that** said dielectric layer comprises at least one of a solid dielectric layer and a gaseous dielectric layer, or a combination of the both mentioned.

9. The reactor according to ~~anyone of the preceding claims,~~ claim 1, **characterized in that** the at least one substrate comprises a plate having a non planar-shaped external surface.

10. The reactor ~~of anyone of the preceding claims~~ according to claim 1, **characterized in that** the at least one substrate (65) has a curved shape.

11. The reactor according to ~~anyone of the preceding claims,~~ CLAIM 1, **characterized in that** spacing members are arranged between said substrate (35', 65) and one of the electrodes (25, 45), said spacing members having elongations being non uniform.

12. The reactor according to claim 11, **characterized in that** the spacing members (89) at the non-substrate-end being surrounded by a space (91), for at least partially compensating the electromagnetic perturbation induced by the contact between the spacing member and the substrate.

13. ~~A~~ process for treating at least one substrate (15, 35', 65) in a radiofrequency plasma reactor (1, 20), comprising the steps of :
- locating the at least one substrate (15, 65) between two electrodes (3, 5), the at least one substrate extending along a general surface (15a),

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- having a circulation of a reactive gas within the reactor, so that such a gas is present in an internal process space (13) arranged between the electrodes,
- having a radiofrequency generator (9) connected to at least one of the electrodes (3, 5), at a connection location (9a),
- having a plasma discharge in at least a zone of the internal process space (13) in such a way that said substrate is exposed to the processing action of the plasma discharge,

characterized in that it further comprises the steps of creating an extra-capacitor electrically in series with said substrate and the plasma, said extra-capacitor having a profile, and

defining the profile of the extra-capacitor in such a way that it has location dependent capacitance per unit surface values along at least one direction of the general surface of the substrate, for generating a given distribution profile, especially for compensating a process non uniformity in the reactor.

14. The process according to claim 13, **characterized in that**

- the radiofrequency discharge is generated at a frequency higher than for example 1 MHz, preferably higher than 19 MHz,
- the at least one substrate has a surface larger than 0.5 m^2,
- and the largest dimension of the substrate surface exposed to the plasma discharge is higher than 0.7 m.

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15. The process of claim 13 or claim 14, **characterized in that** the step of defining the profile of the extra-capacitor comprises the step of defining such a profile having a non planar-shape along a surface, in such a way that said extra-capacitor is materially defined by at least one dielectric layer having a non uniform thickness along said surface.

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